Fig. 1

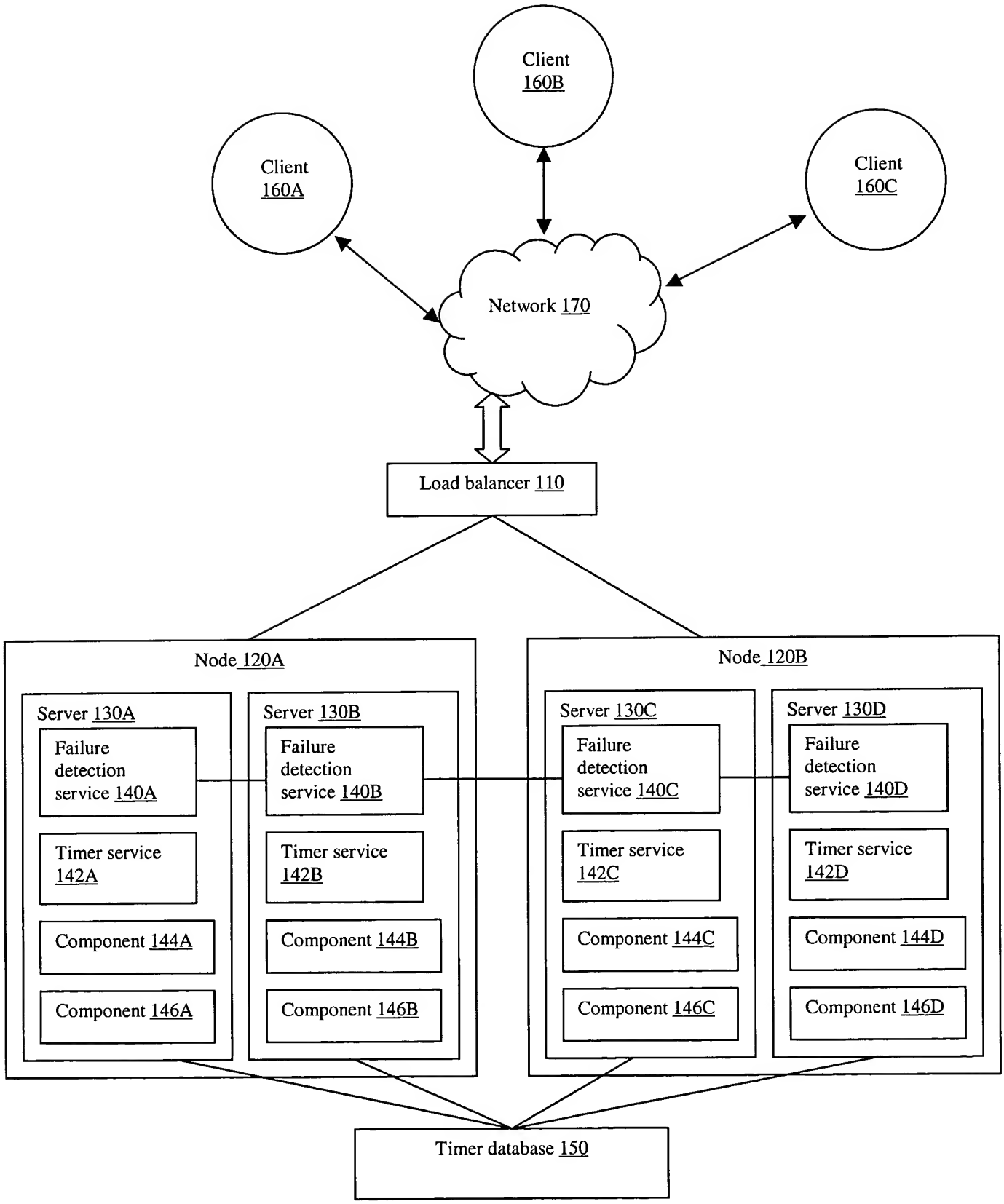

Client 160B
Client 160A
Client 160C
Network 170
Load balancer 110
Node 120A
Node 120B
Server 130A
Server 130B
Server 130C
Server 130D
Failure detection service 140A
Failure detection service 140B
Failure detection service 140C
Failure detection service 140D
Timer service 142A
Timer service 142B
Timer service 142C
Timer service 142D
Component 144A
Component 144B
Component 144C
Component 144D
Component 146A
Component 146B
Component 146C
Component 146D
Timer database 150

Fig. 2

Timer database 150

Timer ID 200	Timer owner 202	Timer interval 204	Timer expire 206	Last active 208	Periodic 210
1	130A	50000	13:00:50.000	13:00:00.000	No
2	130C	20000	13:00:20.000	13:00:00.500	Yes
3	130C	1000	13:02:35.000	13:02:34.100	Yes

Fig. 3

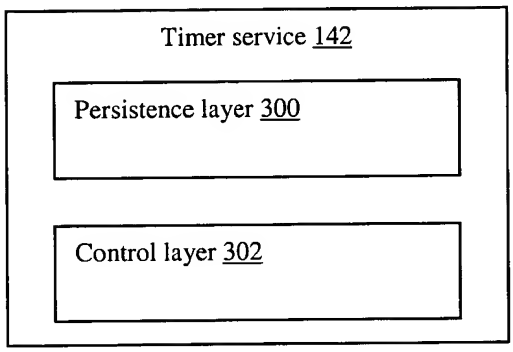


Fig. 4

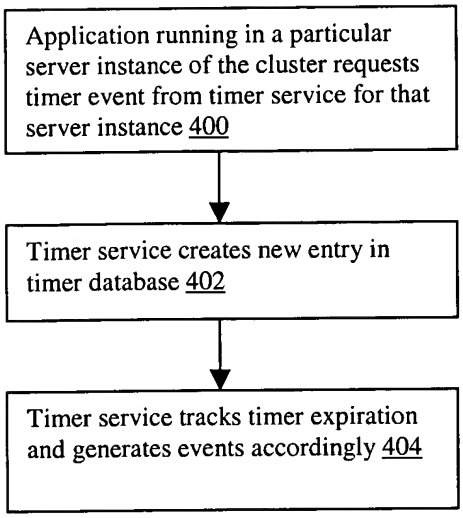

Application running in a particular server instance of the cluster requests timer event from timer service for that server instance 400
Timer service creates new entry in timer database 402
Timer service tracks timer expiration and generates events accordingly 404

Fig. 5

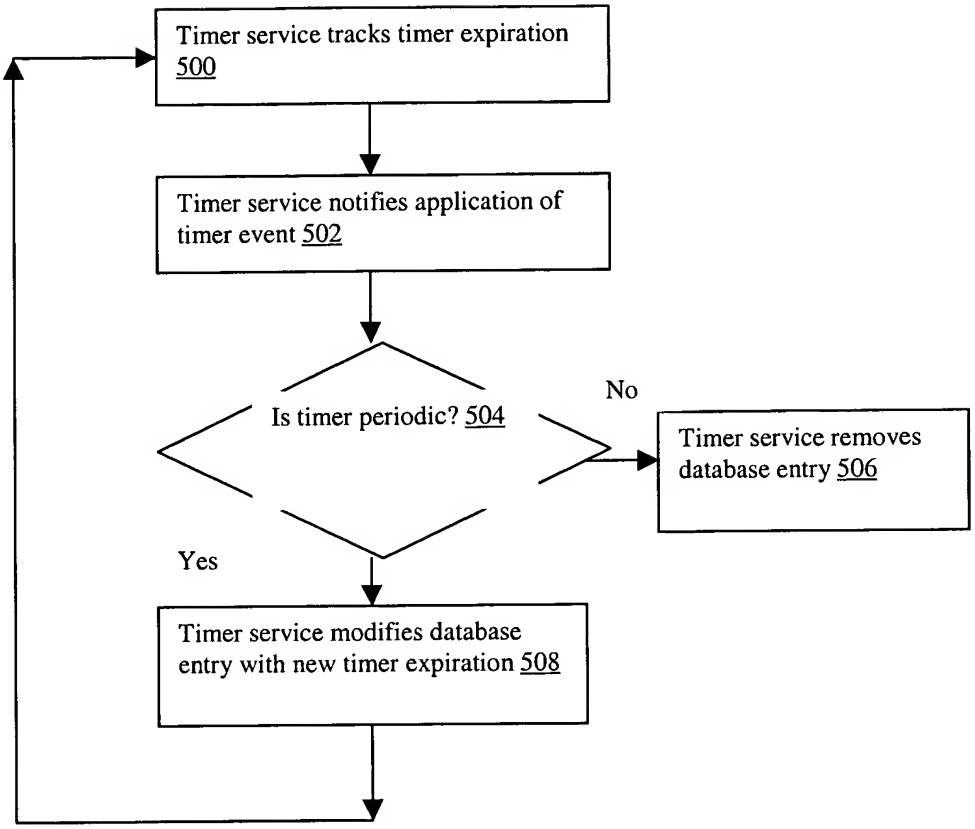

Timer service tracks timer expiration 500
Timer service notifies application of timer event 502
Is timer periodic? 504
No
Timer service removes database entry 506
Yes
Timer service modifies database entry with new timer expiration 508

Fig. 6

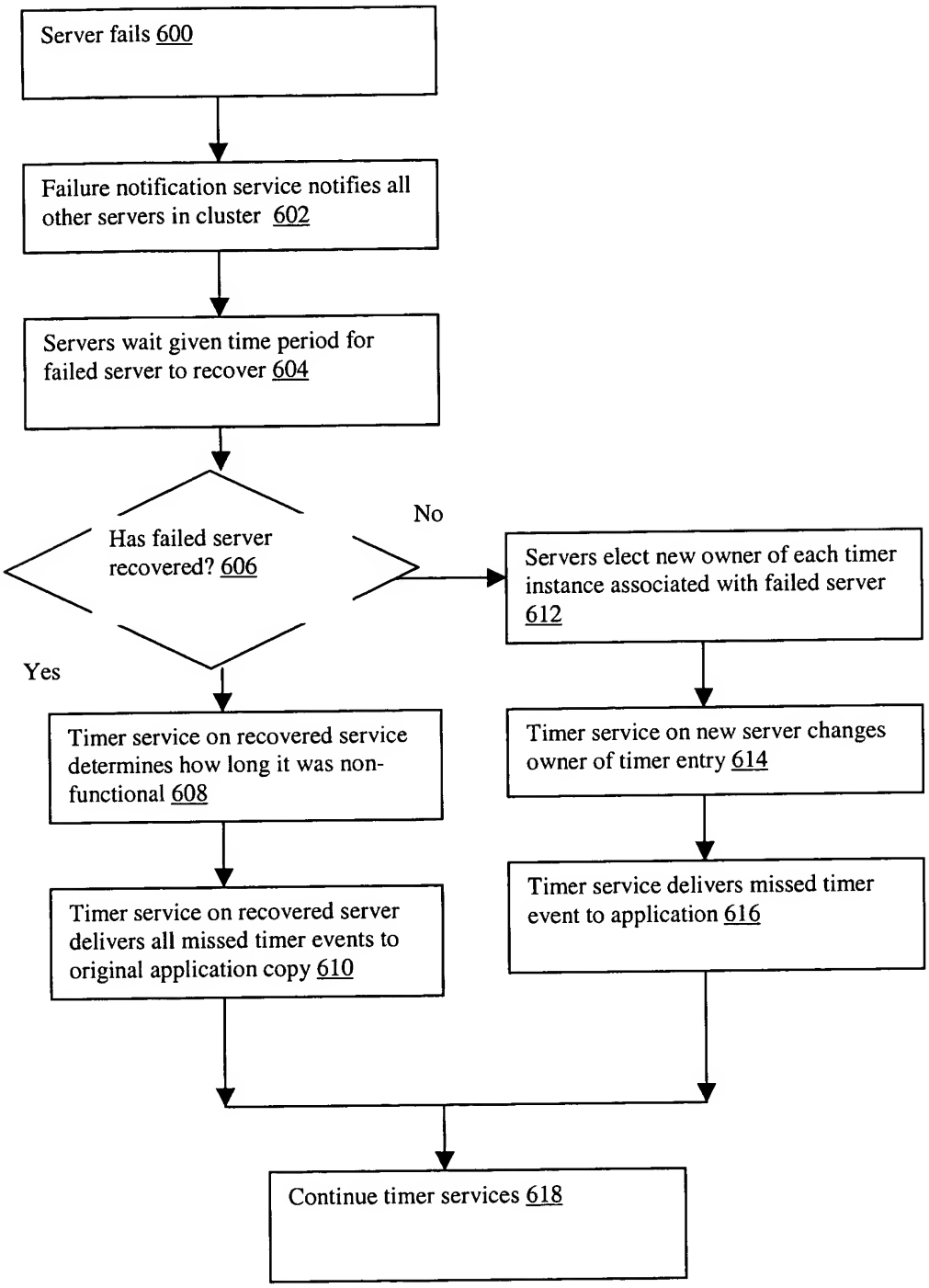

Server fails 600
Failure notification service notifies all other servers in cluster 602
Servers wait given time period for failed server to recover 604
Has failed server recovered? 606
No
Yes
Servers elect new owner of each timer instance associated with failed server 612
Timer service on new server changes owner of timer entry 614
Timer service delivers missed timer event to application 616
Timer service on recovered service determines how long it was non-functional 608
Timer service on recovered server delivers all missed timer events to original application copy 610
Continue timer services 618

Fig. 7

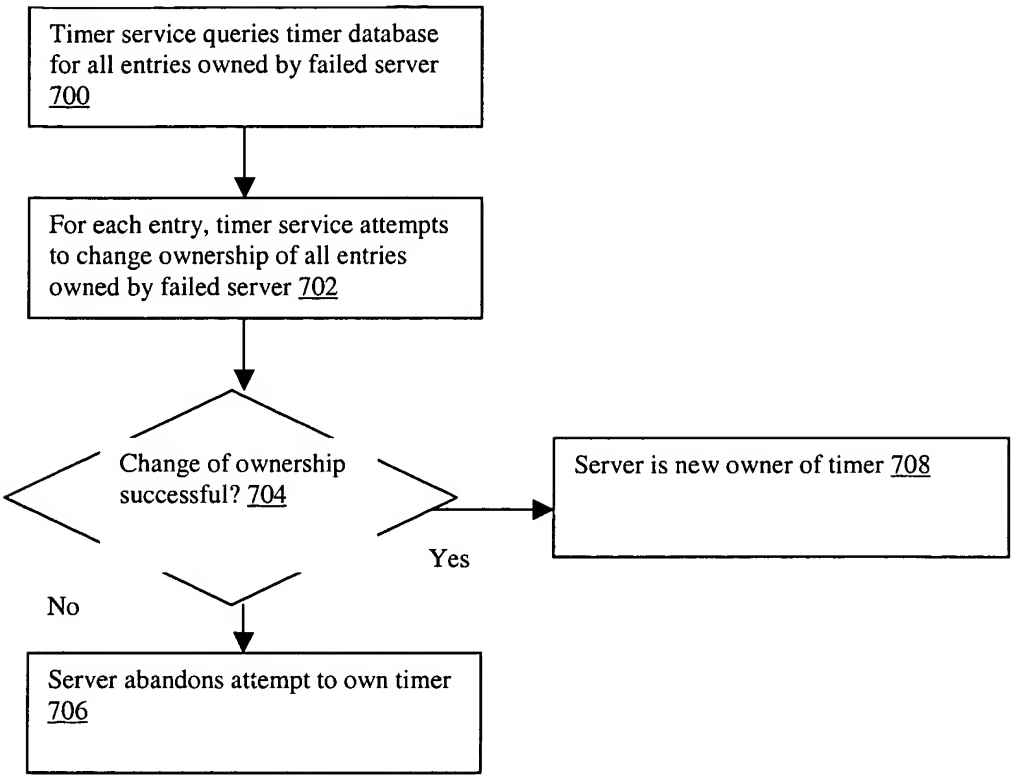
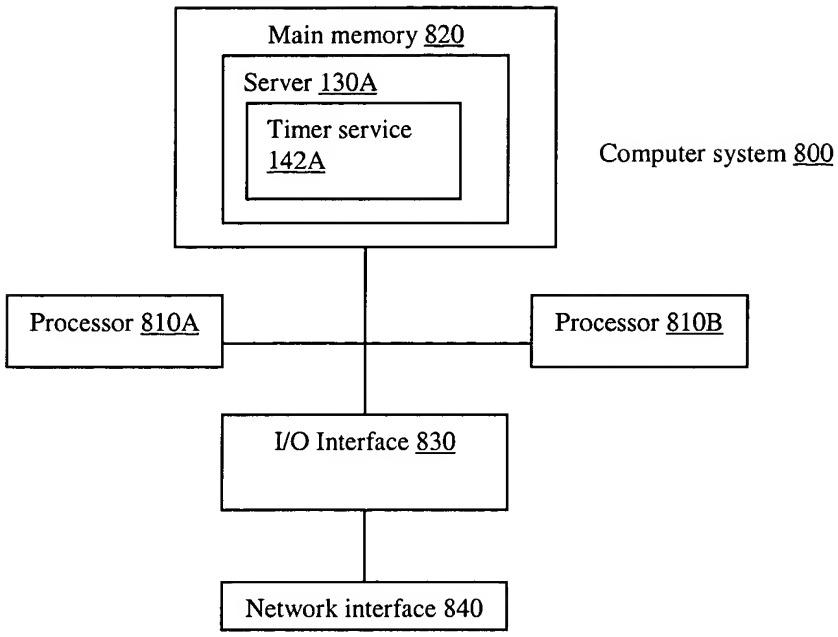

Timer service queries timer database for all entries owned by failed server 700
For each entry, timer service attempts to change ownership of all entries owned by failed server 702
Change of ownership successful? 704
Yes
Server is new owner of timer 708
No
Server abandons attempt to own timer 706

Fig. 8


Main memory 820
Server 130A
Timer service 142A
Computer system 800
Processor 810A
Processor 810B
I/O Interface 830
Network interface 840